PHILIPS

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MULTIMETERS
PM 2410 - PM 2411
(9448 024 10011) - (9448 024 11011)

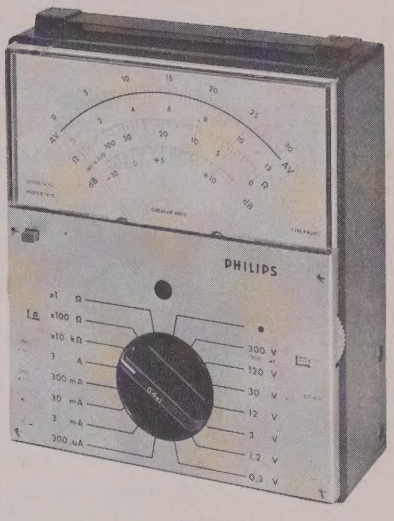
H. T. MEASURING PROBE
PM 9241
(9448 092 41011)

4822 731 10005 M18 1/1266/01

MP MASTER
MA24545

service

PHILIPS *Service*



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SERVICE INFORMATION										

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PM 9241

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I. GENERAL INFORMATION

A. PURPOSE

The PM 2410 and PM 2411 are universal measuring instruments suitable for measuring:

- DC voltages from 0 ... 1200 V
- AC voltages from 0 ... 1200 V
- DC currents from 0 ... 3 A
- AC currents from 0 ... 3 A
- Resistances from 0 ... 10 MΩ

The photographs in these Service Notes show the PM 2411.

In appearance the PM 2410 and the PM 2411 are identical except for the red relay button.

For data concerning operation refer to Directions for Use.

B. TECHNICAL DATA

Measuring range	Current consumption or voltage loss at f.s.d.	Sensitivity	Position of range selector	Position of selector switch	Connect to terminals
D.C. VOLTAGE					
0... 0.3 V	25 µA	40,000 Ω/V	0.3 V	⎓	+; 0-
0... 1.2 V			1.2 V		
0... 3 V			3 V		
0... 12 V			12 V		
0... 30 V			30 V		
0... 120 V			120 V		
0... 300 V			300 V		
0...1200 V			300 V (1200 V)		1200 V⎓; 0-
A.C. VOLTAGE					
0... 1.2 V	30 mA	33.3 Ω/V	1.2 V	∼	+; 0-
0... 3 V	5 mA	200 Ω/V	3 V		
0... 12 V	3 mA	333 Ω/V	12 V		
0... 30 V	300 µA	3330 Ω/V	30 V		
0... 120 V			120 V		
0... 300 V			300 V		
0...1200 V			300 V (1200 V)		1200 V∼; 0-
D.C. CURRENT					
0...120 µA	110 mV		300 µA x "0.4 I"	⎓	+; 0-
0...300 µA	275 mV		300 µA		
0... 1.2 mA	120 mV		3 mA x "0.4 I"		
0... 3 mA	300 mV		3 mA		
0... 12 mA	120 mV		30 mA x "0.4 I"		
0... 30 mA	300 mV		30 mA		
0...120 mA	< 130 mV		300 mA x "0.4 I"		
0...300 mA	< 325 mV		300 mA		
0... 1.2 A	< 160 mV		3 A x "0.4 I"		
0... 3 A	< 400 mV		3 A		

Measuring range	Current consumption or voltage loss at f.s.d.	Sensitivity	Position of range selector	Position of selector switch	Connect to terminals
A.C. CURRENT					
0...120 µA	1.04 V		300 µA x "0.4 I"	~	+; 0-
0...300 µA	2.6 V		300 µA	~	+; 0-
0... 1.2 mA	220 mV		3 mA x "0.4 I"	~	+; 0-
0... 3 mA	550 mV		3 mA	~	+; 0-
0... 12 mA	< 80 mV		30 mA x "0.4 I"	~	+; 0-
0... 30 mA	< 200 mV		30 mA	~	+; 0-
0...120 mA	< 80 mV		300 mA x "0.4 I"	~	+; 0-
0...300 mA	< 200 mV		300 mA	~	+; 0-
0... 1.2 A	< 80 mV		3 A x "0.4 I"	~	+; 0-
0... 3 A	< 200 mV		3 A	~	+; 0-
RESISTORS					
		mid-scale value			
0... 1 kΩ	83 mA	18 Ω	x 1 Ω	⎓	+;0-
0...100 kΩ	0.8 mA	1800 Ω	x 100 Ω	⎓	+;0-
0... 10 MΩ	0.058 mA	180,000 Ω	x 10 kΩ	⎓	+;0-
60 mV D.C.					
0...60 mV	25 µA*	40,000 Ω/V			60 mV; -
dB					
-18...+ 3			1.2 V		
-10...+11			3 V		
+ 2...+23			12 V		
+10...+31			30 V		
+22...+43			120 V		
+30...+51			300 V		
+42...+63			1200 V		

*Only with the range selector in one of the DC voltage positions.

C. EXPLANATION TO THE TABLE

The values given in the table above apply in case of full-scale deflection. For smaller deflections the voltage loss and current consumption are proportionally lower.
All current and voltage scales are linear. The AC current and AC voltage ranges have been calibrated with a purely sinusoidal voltage. Reading remains accurate at frequencies from 30 Hz...10 kHz, except in the "1200 V~" measuring range, for which the frequency range is 30 Hz...5 kHz.

D. ACCURACY

The instrument has been calibrated in horizontal position.
The maximum deviations at any reading are:

DC voltage	: 1.5 % of full-scale deflection
AC voltage	: 2.5 % of full-scale deflection
DC current	: 1.5 % of full-scale deflection
AC current	: 2.5 % of full-scale deflection
Resistance	: 2.5 % in mid-scale position

DC voltage 60 mV: 1.5 % of full-scale deflection at 20 ^{o}C.

Each degree Centigrade temperature variation results in an additional deviation of 0.3 %.

E. dB-SCALE

The dB-scale ranges from -10 dB...+11 dB, while 0 dB corresponds to 1 mW in 600 Ω.

II. CIRCUIT DESCRIPTION (Figs. 1...7)

A. TAUT BAND SUSPENSION

As the moving coil is suspended between two torsion strips, meter ME1 has no bearing friction, hence a great sensitivity is obtained (25 μA). The meter can be adapted to the various current and voltage ranges, by switching in the appropriate shunt or series resistor with SK4 (Figs. 1 and 2).
The instrument is provided with two sockets for the 1200 V ranges (AC and DC) to eliminate flash-over in the range selector. Between the sockets and the relevant attenuators a resistor has been connected so that a voltage divider is obtained (for DC voltages by means of R27 and for AC voltages by means of R13).
The heavy lines in circuit diagrams 3...7 form the measuring circuits for the relevant measurements.
When alternating currents and alternating voltages are measured, a direct current through the meter is obtained with the aid of germanium diodes GR1 and GR2.
Alternating voltages and currents are measured via current transformer T1. In the 60 mV range the instrument is connected direct to the input sockets; so the system is not protected against overload.
By depressing button "0.4 x I" protection relay RE1 (or R30 of PM 2410) is short-circuited. The current through ME1 is 2.5 times as large as the original current, so the measuring range becomes 0.4 times the value indicated on the text plate. Note that the protection relay of the PM 2411 is now switched off!

The pointer can be adjusted to zero on the "Ω" scale with potentiometer R24, if SK3 is set to the resistance-measuring position and connection terminals "+" and "0-" are short-circuited.

B. PROTECTION OF MEASURING SYSTEM PM 2411

1. Principle (see Fig. 19)

The protection circuit contains a relay which is located around a moving-coil system. This system has a core magnet and is thus quite insensitive to external magnetic fields. Around core magnet T a frame W rotates with two coils, the winding directions of which are opposite to each other. As soon as a current flows through one of the coils, rod R rotates along with frame W. If the current exceeds a certain value, rod R passes screen S. The rod is attracted by magnet M and hits switching-arm P. This causes the switching mechanism to become operative and the entire measuring circuit is cut off.

2. Circuit (Fig. 20)

The relay RE1 contains contacts connected to socket "0-", and two coils, SP1 and SP2. Energising coil SP1 is connected in series with the moving coil. Coil SP2 becomes operative at reversed currents (deflection to the left).
At a current flow from A to B, no current will pass through SP2 because diode GR3 is cut off. Hence the current passes through SP1 and when it exceeds a certain value, the switching mechanism will become operative and the measuring circuit after terminal "0-" is cut off.
If the meter is wrongly polarised in case of DC voltage or current measurements, a current will flow from B to A via both coils. As the impedance of GR3 + SP2 is now many times smaller than the impedance of the branch formed by ME1 + Rv + SP1 (Rv = R1 + R2 + Rc1 + Rc2), the current through SP2 will dominate.
If the limit value is exceeded, the switching-mechanism becomes operative in the same way because of opposite winding directions of SP1 and SP2.

C. SHORT-PERIOD PROTECTION GR3-GR4 (PM 2410 and PM 2411)

When the measuring instrument is overloaded for a short period, depending on the polarity, one of the diodes will be conductive and prevent damage to the instrument. The current through the meter is limited to about 8 x f.s.d.

III. GAINING ACCESS TO THE PARTS

A. REMOVING THE TEXT PLATE (Fig. 9)

- After loosening four screws "A" the text plate can be removed.

B. REMOVING RESET PUSH-BUTTON, KNOB OF AC-DC SWITCH AND KNOB OF Ω-ZERO ADJUSTING POTENTIOMETER

- Remove the text plate (see A)
- Reset push-button B can be lifted out (mind the spring)
- Remove metal indication strip "Ω ⎓ ↓ ~ ↑" (C)
- The grey knobs (Ω-zero adjusting knob D and AC-DC switch knob E) can be taken out (Mind the ratchet spring of the right-hand knob)

  Note: When refitting the left-hand knob, mind the correct position of the stop at the rear (it should be possible for the potentiometer to be turned through approx. 200^{o}).

Do not pull the range selector knob out of the instrument!

C. REMOVING THE REAR PANEL

- Place the instrument upside down
- Loosen the screw with a coin
- The panel can be lifted from the housing (top-side first).

D. REMOVING THE TWO PRINTED WIRING BOARDS (Fig. 10)

- Remove the reset push-button, knob of Ω-zero adjusting potentiometer and knob of AC-DC switch (see B)
- Remove the rear panel (see C)
- Lift both connection blocks out of the housing
- Loosen the cut-out relay by means of screw "C" (PM 2411 only).
- Loosen four screws "B" but do not remove them.
- Together with the relay, the printed wiring boards can now be lifted out of the case (vertically). By bending the cable form the printed wiring boards and the relay can be placed next to the housing. Secure the 4 screws "B" by means of 4 crocodile clips (Fig. 11).
- When refitting the printed wiring boards, make sure that the 4 spacers are in place and that the rotors of the range selector are in the right positions (see Fig. 23)
- Lift the four screws because otherwise they may miss their respective "columns"
- Replace the cut-out relay, the four screws "B" and the two blocks with input sockets
- Close the instrument again.

IV. REPLACING PARTS

The operations below should be carried out in dust-free and sufficiently illuminated surroundings.

A. MEASURING SYSTEM WITH Rc1

- Remove the rear panel.
- Remove the batteries.
- Remove locking springs D (see Fig. 10) with a pair of tweezers by pressing them together.
- Remove the brown disc at the rear of the instrument housing.
- Unsolder the connections of the moving coil (two thin black wires) at points E and F (Fig. 10).
- Turn the instrument face up.
- Remove the text plate (III. A).
- Remove the two screws in the transparant window.
- Remove the window.

  Do not touch the inside of the window because it has been treated with an anti-static liquid. By touching the window it may loose its anti-static properties and, moreover, become stained.
- Scale, magnet and moving coil system can be lifted from the instrument as one unit.
- Place the new system, the connection wires and the brown disc in their proper positions and refit the window.
- Turn the instrument upside down.
- Resolder the two connection wires of the system and refit locking springs D.
- Replace the old correction resistor of the measuring system (Rc1, Fig. 10) by the resistor supplied with the new system.
- Check the measuring system according to point V. E.
- Close the instrument.

B. CUT-OUT RELAY WITH Rc2 (PM 2411 only)

- Remove the rear panel (III. C).
- Secure the push-button with a crocodile clip.
- Loosen screw "C" (Fig. 10).
- Pull the relay out of the instrument housing in the vertical direction (together with Rc2).
- Unsolder the relay leads.
- Check the new relay according to point V. C.
- Connect the appropriate wires to the connection points of the relay.
- Mount the new relay (together with the new Rc2) and fasten screw "C" again.
- Refit the rear panel.

C. RELAY CONTACTS (Fig. 17) PM 2411 only

- Take the relay out of the instrument (IV. B).
- Set the relay to "off" position by quickly rotating it.
- Loosen screw "B", remove fixed contact spring "C" and small plate "F".
- Pull movable contact spring "D" around the cam of slide "S" so that it is horizontal.
- Lift tension spring "V" out of contact spring "D" with a pair of tweezers.
- Remove contact spring "D".
- Lift tension spring "V" out of tension spring holder "T" with a pair of tweezers.

- Fit the new tension spring in the tension spring holder (see Fig. 21).
- Loosen screw "A".
- Slide tension spring holder "T" to the right so that the lower hook of tension spring "V" is clamped between the relay housing and the tension spring holder, and tighten screw "A" again.
- Position new contact spring "D" horizontally (Fig. 22).
- Attach tension spring "V" to this contact spring.
- Move contact spring "D" around the cam of the slide and place the spring vertically so that the bottom side fits into the groove of carrier "E".
- Secure the new contact spring "C" with screw "B".
- Loosen screw "A" approx. a quarter of a turn.
- Adjust spring holder "T" so that contact spring "D" hits "C" when switching arm "P" has been moved by the slide past weak iron screen "S" (Fig. 19).
- Tighten screw "A".
- Adjust the fixed contact spring to the correct height so that both contact faces are firmly positioned against each other.
- Adjust the distance between movable contact spring "D" and the cam on slide "S" to 0.3... 0.5 mm by bending fixed contact spring "C" (Fig. 18).
- Mount the cut-out relay (IV.B).

D. SLIDE OF THE CUT-OUT RELAY (S1, Fig. 16) PM 2411 only

- Take the relay out of the housing as described under IV.B.
- Set the relay to "off" position by quickly rotating it.
- Mind the position of spring "M".
- Loosen both screws "N" and remove the lid.
- Take roller "0" from the slide.
- Remove the slide with spring "L" and spring guide "K".
- Fit the spring and the spring guide into the slide.
- Place roller "0" on the slide.
- Position the slide in the relay and ensure that the spring is straight.
- Check that the three lead-through contacts 1-2-3 are fitted in the appropriate recesses.
- Mount the lid so that the pin on slide "S" fits in the guide groove of switching arm "P" and ensure that spring "M" is in the proper position.
- Reassemble the cut-out relay (IV.B).

E. RANGE SELECTOR KNOB

This knob should be removed only when parts of the knob or the knob itself have to be replaced.

1. Removing

- Set the range selector to the position marked with a dot (for damping and as reference).
- Remove the text plate (III.A) and the rear panel (III.C).
- Carefully pull the knob out of the instrument. The knob contains two balls, which spring into the tray under the knob.

2. Disassembling (Fig. 13)

- Compress "hair pin" spring A at the neck of the knob so that the spring ends are as close to each other as possible.
- Slide the "hair pin" spring approx. 1 cm back.
- Remove strip "0.4 x I".

3. Assembling

- Compress the "hair pin" spring at the neck of the knob so that the spring ends are as close to each other as possible.
- Press strip "0.4 x I" (B) into the groove so that the 0 of "0.4 x I" is next to the white indication line.
- Slide the "hair pin" spring forward.

4. Mounting

- Insert a wire of approx. 1 mm dia.(e.g. mounting wire), with a length of approx. 7 cm, into one hole (Fig. 14).
- Slide a ball and the spiral spring into the other hole.
- Press the second ball on the spring until it disappears into the hole.
- Block this ball with the second wire (identical to the first one).
  The ends of the wires should not protrude from the holes.
- Apply a thin film of grease (preferably silicon grease) on the rear of the knob to prevent friction when the knob is turned in the tray.
- Insert the knob (mind the indicating line pointing to the black dot) with the two wires through the hole into the tray and, if the printed wiring boards have not been removed, also through the rotors of the range selector.
  Mind the position of these rotors (Fig. 23)!
- Pull the wires out of the knob at the rear of the instrument.
- Refit rear panel and text plate.

F. ROTORS, ROTOR CONTACTS AND SPIRAL SPRING OF THE MEASURING RANGE SELECTOR

- Remove the two printed wiring boards (III.D).
- Unsolder the connections between the printed wiring boards at one side, so that the boards can be hinged out.
- Remove the rotors and the spiral spring.
- Replace the rotor(s) or the spiral spring.
- Clean the contact faces with alcohol.
- Check the rotor contacts and if necessary, replace them by new ones.
  Mind the spring between rotor body and rotor contact.
- Apply a thin film of oil (for ordering number see chapter VIII. A) on all contact faces.
- Refit the rotors and the spiral spring, resolder the disconnected wires and mount the printed wiring boards according to III.D.

Note:

To avoid play of the measuring range knob in the rotors as a result of tolerances in the material, spacers (0.15 mm) have been applied in the instruments from the beginning of the series (see Fig. 23).

G. ROTOR-CONTACTS OF SWITCH ⎓/∼

Replacing can be carried out according to point F by turning the switch until the contacts are outside the printed wiring board.

H. PRINTED WIRING BOARDS

Note:

The printed wiring board U_A, which is supplied by Central Service, can be used both for PM 2410 and for PM 2411. For PM 2410 resistor R30 and an extra interconnection wire should be mounted. Printed wiring board U_B is identical for both instruments.

1. Printed wiring board U_A for PM 2411 (Fig. 25)
   - Remove the two printed wiring boards (III.D).
   - Remove the four screws and the four spacers between the printed wiring boards.
   - Unsolder all connections from U_A.
   - Remove the printed wiring board, the rotors and the spiral spring.
   - Unsolder Rc1 (Fig. 10) from the old unit and solder it to the corresponding points of the new unit.
   - Refit the rotors, the spiral spring and the printed wiring board, resolder the disconnected wires and mount the printed wiring boards according to III.D.

2. Printed wiring board U_A for PM 2410 (Fig. 26)
   - First proceed according to point IV.H.1.
   - Unsolder R30 from the old unit and solder it to the new unit.
   - Interconnect points A and B.

3. Printed wiring board U_B (PM 2410 and PM 2411)
   - Remove the two printed wiring boards (III.D).
   - Remove the four screws and the four spacers between the printed wiring boards.
   - Unsolder all connections from unit B.
   - Remove the printed wiring board, the rotors and the spiral spring.
   - Refit the rotors, the spiral spring and the unit, resolder the disconnected wires and mount the printed wiring boards according to III.D.

J. LEAF SPRINGS ON U_A

As both leaf springs are fitted in the same way, the replacement of one of them will be described.

- Remove the two printed wiring boards (III.D).
- Unsolder the connections between the printed wiring boards at one side so that the boards can be hinged out.
- Unsolder the leaf spring.
- Fit the new leaf spring in the position according to Fig. 24a; bend the protruding lugs of the spring and solder them.
  The springs should not touch each other.
- Resolder the disconnected wires.
- Assemble the entire unit according to III.D.
- When this is done, the range selector knob will lift the spring for the "0.4 x F" switch. This spring should be centred between the printed wiring board and the bracket according to Fig. 24b. The same applies to the other spring, but special care must be taken that on turning the knob the cam on the rotor does not run against the spring.
  Adjustment takes place by bending at point A.

- Depress push-button "0.4 x I". Contact should now be made between the spring over the centre of the measuring range selector and the bracket.
- Successively set the measuring range selector to positions 3 A, 300 mA, 30 mA, 3 mA and 300 µA. Owing to the cam on the rotor contact should be made in these five positions between the second leaf spring and the bracket.

K. CURRENT TRANSFORMER T1 (Fig. 15)

- Take out the printed wiring boards.
- Unsolder the transformer connections.
- Unsolder the fixing wires.
- Fit the new transformer in its proper position and secure the fixing wires in the same way as the old ones.
- Fit an extra turn (1 mm diameter) round the core of the transformer (3-A turn). Mind the winding direction.
- Solder the leads to their relevant positions.
- Refit the printed wiring boards (III.D).

L. BATTERY CONTACT-SPRINGS AND BATTERY SPRING-HOLDER

- Remove the measuring system (IV.A).
- Unsolder the wire(s) from the contact spring(s) or spring holder to be replaced.
  The grey wire corresponds to the +9 V pole, the blue one to -1,5 V and the red one to the common -9 V/+1.5 V pole.
- Straighten the soldering tag and remove the contact spring or the spring holder by lifting them out of their grooves (rear).
- Slide the new spring or spring holder into the groove.
- Solder the wire(s) to the tag(s) and bend the tag(s).
- Refit the measuring system (IV.A).

M. BATTERIES

- Remove the rear panel (III.C) and take out both batteries.
- Push the bottom sides of the new batteries against the spiral springs and slide the pole(s) into the contact slots. The construction of the battery compartment is so that the batteries can make contact in one position only (see Fig. 12). The polarity is indicated at the bottom of the battery compartment.
- When short-circuiting sockets "+" and "0-", check that the pointer can be set to zero of scale "Ω" with knob "Ω" (left side) in all resistance measuring ranges.
- Refit the rear panel.

Recommanded batteries

Normal and leakproof batteries may be used.

Made in	Make	1.5 V type*	9 V type*
Denmark	Hellesens	VII 26	H10
England	Berec	U11; PP13	PP3
France	Cipel	-	R0603
	Leclanché	R 14 L	6 F 20 L
	Wonder	Escal; Babix	Tiber; Tokio
Germany	Pertrix	235; 214	438
Italy	Super pila	61	987
The Netherlands	Witte kat	56a; 668	514
	Philips	R 14	U - 6 F 22
Switzerland	Leclanché	605; 610	815
U.S.A.	Burgess	1-130	246
	Eveready	635; 835; 935	216
	Ray-o-vac	1 LP 14	1604

* max. dimensions 26 dia. x 50 mm

** max. dimensions 26 x 15 x 50 mm

N. GRIP

- Remove the rear panel (III. C).
- Take out the batteries.
- Take out the relay (IV. B).
- Straighten the upper lugs of the grip retainers; it is not necessary to bend the lower lugs.
- Remove the retaining springs.
- Remove both grip retainers.
- Exchange both retainers (right-hand retainer becomes left-hand retainer and vice versa) and position the new grip.
- Refit the retaining springs.
- Push the lower lugs downwards.

O. RUBBER STUDS

- Remove the rear panel (III. C).
- Insert the new stud(s) through the opening of the rear panel from the inside (point outwards).
- Pull the rubber stud tightly against the panel and cut off the excessive material.

V. CHECKING AND ADJUSTING

A. RESISTORS AND CAPACITORS

When one of the correction resistors has to be replaced (for position, see Fig. 10) adjust it according to chapters V.D and V.F. to the exact value.
After replacing another resistor or a capacitor, no adjustment is necessary; however, the tolerances shown in the list of electrical parts should be taken into account.
A spare resistor (R9'; Fig. 10) has been provided in case resistor R9 should become defective. Since in the directions for use it is explained how a customer can use this resistor it is advisable to check that R9 as well as R9' are present after repairs.

B. DIODES GR1...GR4

After replacing no adjustment is necessary.

C. RELAY (PM 2411 only)

- Depress the slide
- Connect a galvanometer with a range of 100 μA in series with Rc2 and coil SP1 (the coil is located between 2 (+) and 3 (-) in Fig. 16).
- Allow a direct current of 40 to 80 μA to pass through this circuit.
- The relay should switch off.
- Connect the same galvanometer in series with SP2 (the coil is located between 1 (+) and 2 (-) in Fig. 16).
- Allow a direct current of 40 to 80 μA to pass through this circuit.
- The relay should switch off.

Remark

- Do not try to readjust magnet M (Fig. 19) with the screw at the rear of the relay as the bracket has been glued down in the correct position by the factory.
- If the relay is included in the circuit the measuring circuit is interrupted in case of a positive current at 3 to 4 times the full-scale value. If the current direction is negative, the circuit is interrupted at 7 to 8 times the full-scale value.

D. CORRECTION RESISTOR FOR RELAY (Rc2) PM 2411 only

When resistor Rc2 must be replaced without replacing the relay itself, its value must be chosen so that the resistance of coil SP1 + Rc2 is 2400 Ω. For this purpose Central Service supplies a resistor that can be unwound until the right value is obtained.

Adjustment

- Set the meter to zero mechanically.
- Short-circuit R1 and R2.
- Unsolder Rc1 at the end which is connected to the "0-" socket.
- Mount Rc2 so that it is easy to unwind this resistor.
- Connect point 2 of the relay (Fig. 16) to the positive pole of a d.c. voltage source of 120 mV.
- Connect the unsoldered side of Rc1 to the negative pole of the voltage source.

- Unwind Rc2 until the meter shows full-scale deflection (= 25 μA).
  The resistance of the series circuit (SP1 + Rc2 + ME1 + Rc1) is then $\frac{120\ mV}{25\ \mu A} = 4800\ \Omega$.
  SP1 + Rc2 is now 2400 Ω, because ME1 + Rc1 is also 2400 Ω.
  During the adjustment the voltage across the circuit must remain at 120 mV.
- Resolder Rc1 again.
- Mount Rc2 in its definite position with an additional rigid piece of wire.

E. MEASURING SYSTEM (with Rc1)

The new measuring system has been adjusted to a resistance of 2400 $\Omega \pm 0.5$ % at an ambient temperature of 20 ^{o}C, by means of the correction resistor supplied. As the scale is calibrated with the system belonging to it, there remains only the checking of the correct sensitivity for full-scale deflection (25 μA), keeping in mind the influence of the temperature (approx. 0.3 % per Centigrade).

Method A (with galvanometer)

- Set the meter to zero mechanically.
- Connect a galvanometer, accuracy $\leq \pm 0.5$ % (preferably 0.2 %), in series with the meter system and correction resistor Rc1.
- Apply a current of 25 μA to this circuit.
- The meter must show full-scale deflection. Tolerance 0.5 %.

Method B (if no galvanometer is available)

- Set the meter to zero mechanically.
- Connect a resistance box in series with the meter system and correction resistor Rc1.
- Adjust the resistance box to so high a value that the resistance of the system with correction resistor Rc1 (2400 Ω) is low in comparison with that of the box.
- Apply a variable direct voltage to the above-mentioned circuit.
- Adjust this voltage to such a value that full-scale deflection is obtained and measure the voltage across the series circuit with an accurate DC-voltmeter (tolerance ≤ 0.5 %, preferably 0.2 %).
- The current can be calculated by dividing voltage and resistance of the resistance box. The result should be 25 $\mu A \pm 0.5$ %.

Note:

On delivery the measuring system is balanced. If, in spite of that, some correction is required (difference between horizontal and vertical position greater than 1 division of the scale 0...12), consult Service Information Cd 174.

F. CORRECTION RESISTOR FOR MEASURING SYSTEM (Rc1)

When this resistor should be replaced while the measuring system ME1 should not, the resistor supplied by Central Service (identical to Rc2) can be used and should be unwound until the resistance of ME1 + Rc1 is 2400 Ω. (Keep in mind the influence of the ambient temperature, point E.)

Adjustment

- Set the meter to zero mechanically.
- Connect a galvanometer (accuracy ≤ 0.5 %, preferably 0.2 %) in series with the meter system.
- Apply a current of 25 μA to this circuit.
- The meter must show full-scale deflection.
- Mount Rc1 in series with the system so that it is easy to unwind.
- Apply a d.c. voltage of 60 mV to this series circuit.
- Unwind Rc1 until the meter shows full-scale deflection. The voltage across the circuit should remain constant at 60 mV during adjustment.
- Mount Rc1 in its definite position.

VI. TRANSPORT

When transporting the instrument, set the range selector to the position marked with a dot. In this position the measuring system is short-circuited so that it is protected against damage from the resulting damping.

VII. ANTI-STATIC TREATMENT

The transparent window of the instrument is coated on the inside with a colourless liquid with antistatic properties in order to eliminate static charges which might affect the deflection of the pointer and attract dust. This side should never be rubbed with a cloth or similar material as this would cause the window to become dull, and the anti-static effect would be lost. The windows supplied by Central Service do not possess this anti-static coating. The liquid required to make a window anti-static is supplied separately; for the code number refer to the list of mechanical parts.

Generally the following applies:

- Use but little anti-static liquid.
- Spread the liquid with a brush and rub it firmly on the window as if it were applied on a porous surface.
- Breath on the treated surface as is done with spectacle glasses before cleaning.

VIII. LIST OF PARTS

A. MECHANICAL

Item	Fig.	Qty.	Ordering number	Code number	Description	Remark
1	8	1	4822 498 30028		Grip	
2	8	2	4822 498 70027		Grip retainer	
3	8	1	4822 693 90085		Housing	
4	8	1	4822 535 40023		Mechanical zero-adjusting screw	
5	8	1	4822 410 20391		Push-button	For switch "0.4 x I"
6	8	1	4822 411 20071		Range selector knob	Without push-button "0.4 x I"
7	8	1	4822 455 90216		Text plate	PM 2410
		1	4822 455 90217		Text plate	PM 2411
8	9	1	4822 413 40243		Knob	For switch ⎓/∼
9	9	1	4822 492 60859		Ratchet spring	For switch ⎓/∼
10	9	1	4822 693 90111		Transparant cap	See VII
11	9	1	4822 492 50436		Push-button spring	For PM 2411 only
12	9	1	4822 410 20403		Relay push-button	For PM 2411 only
13	9	1	4822 413 40242		Knob	For Ω-zero adjustment
14	10	2	4822 492 60857		Retaining spring	For item 10
15	10	1	4822 280 20012	RC2	Relay	For PM 2411 only
			4822 310 20048	-4822 136 00052	Set of relay contacts with 2 springs	For PM 2411 only
16	10	1	4822 267 40082		Block with four sockets	
17	10	2	4822 492 60861		Leaf contact spring	For switch "0.4 x I" and current ranges
18	10	1	4822 267 30121		Block with two sockets	
19	10	2	4822 492 60858		Battery-contact leaf spring	
20	10	1	4822 466 80174		Battery spring-holder	For item 21
21	10	2	4822 492 50449		Battery contact	Spiral spring
22	11	2	4822 404 50147		Rotor	For range selector
23		1	4822 492 50438		Spiral spring between the rotors (item 22)	
24		1	4822 404 50146		Rotor	For switch ⎓/∼
25	11	1	4822 492 60862		Cup spring	For rotor ⎓/∼ switch
26		1	4822 532 50421		Washer under cup spring (item 25)	
27		5	4822 278 90141		Moving contact	For all switches
28	13	7	4822 492 50439		Spring	For all moving contacts and button "0.4 x I"
29	13	2	4822 520 40012	89 205 03	Ratchet ball	For range selector
30	13	1	4822 492 50437		Spiral ratchet spring in range selector knob	

Item	Fig.	Qty.	Ordering number	Code number	Description	Remark
31		1	4822 693 90036		Rear panel	
32		4	4822 462 40109	P5 675 05	Rubber stud	
33		1.5 m	4822 323 20053	R783 KA/03J	Measuring flex	Grey
34		2	4822 264 30033	978/1x4AP	Plug 4 mm	Black
35		2	4822 264 30034	978/1x4FP	Plug 4 mm	Red
36		1	4822 264 20011	978/140AA	Measuring pin	Black
37		1	4822 264 20012	978/140AF	Measuring pin	Red
		30 cc	4822 390 80002	A9 868 76	Bottle with anti-static liquid	
		30 cc	4822 390 10007	971/71	Bottle with switch oil	
			4822 390 20011	4822 172 01383	Silicon grease	

B. ELECTRICAL

Resistors

No.	Ordering number	Code number	Value	Power	Tol.	Remark
R1	4822 111 20074	B8 305 17D/4K8	4.8 kΩ	0.25 W	1 %	
R2	4822 116 50203		1.4 kΩ	0.25 W	1 %	
R3	4822 110 30068	901/36E				
	+ 4822 110 30111	+ 901/1K3	35 Ω	0.25 W	1 %	in parallel
R4	4822 110 30101	901/560E				
	+ 4822 110 30128	+ 901/6K2	523 Ω	0.25 W	1 %	in parallel
R5	4822 110 30123	901/3K9				
	+ 4822 110 30172	+ 901/270K	3.85 kΩ	0.25 W	1 %	in parallel
R6	4822 110 30159	901/91K	91 kΩ	0.25 W	1 %	
R7	4822 110 30173	901/300K	300 kΩ	0.25 W	1 %	
R8	2x 4822 110 30189	2x 901/1M2	600 kΩ	0.25 W	1 %	two, in parallel
R9	4822 113 50037	48 762 01/17E5	17.5 Ω	0.25 W	1 %	
R10	4822 110 30122	901/3K6				
	+ 4822 110 30123	+ 901/3K9	1870 Ω	0.25 W	1 %	in parallel
R11	4822 111 20251		154 kΩ	0.25 W	1 %	
R12	4822 111 20252		44.9 kΩ	0.25 W	1 %	
R13	4822 110 30199	901/3M	3 MΩ	0.25 W	1 %	
R14	4822 110 30107	901/1K	1 kΩ	0.25 W	1 %	
R15	4822 111 20071	B8 305 17D/400E	400 Ω	0.25 W	1 %	
R16	2x 4822 110 30087	2x 901/180E	90 Ω	0.25 W	1 %	two, in parallel
R17	2x 4822 112 10061	2x 901/W18E	9 Ω	0.4 W	1 %	wire-wound; two, in parallel
R18 R19	4822 115 80071		0.1+0.9 Ω		½ %	shunt
R20	2x 4822 110 30107	2x 901/1K	500 Ω	0.25 W	1 %	two, in parallel
R21	4822 110 30148	901/36K	36 kΩ	0.25 W	1 %	
R22	4822 110 30157	901/75K				
	+ 4822 110 30194	+ 901/1M8	72 kΩ	0.25 W	1 %	in parallel
R23	4822 110 40149	902/P39K	39 kΩ	0.5 W	5 %	
R24	4822 101 10024	E 097 AD/20K	22 kΩ			potentiometer
R25	4822 110 30175	901/360K	360 kΩ	0.25 W	1 %	

No.	Ordering number	Code number	Value	Power	Tol.	Remark
R26	4822 110 30189	901/1M2				
	+ 4822 110 30194	+ 901/1M8	720 kΩ	0.25 W	1 %	in parallel
R27	4x 4822 111 40169		36 MΩ	0.5 W	1 %	four, in series
R28	4822 110 30202	901/3M6	3.6 MΩ	0.25 W	1 %	
R29	4822 111 40171		7.2 MΩ	0.25 W	1 %	
R30	4822 110 30117	901/2K4	2.4 kΩ	0.25 W	1 %	PM 2410 only
Rc1	4822 113 30003	E 102 BA/B820E	820 Ω			adjustable
Rc2	4822 113 30003	E 102 BA/B820E	820 Ω			adjustable (PM 2411 only)

All resistors are carbon resistors, unless stated otherwise.

Capacitors

No.	Ordering number	Code number	Value	Voltage	Tol.	Description
C1	4822 120 30143	906/22K	22 nF	250 V	10 %	Polyester
C2	4822 120 30143	906/22K	22 nF	250 V	10 %	Polyester

Miscellaneous

T1	4822 142 70042	Current transformer
ME1	4822 344 50029	Measuring system with magnet and scale
U_A	4822 216 70054	Printed wiring board A with components (see IV.H)
U_B	4822 216 70053	Printed wiring board B with components (see IV.H)
GR1	OA85	Germanium diode
GR2	OA85	Germanium diode
GR3	BA100	Silicon diode
GR4	BA100	Silicon diode

PM 9241

A. GENERAL

The probe PM 9241 has been designed for measuring direct voltages up to 30 kV in combination with PM 2410 or PM 2411. The probe has to be connected to the sockets "+" and "0-" of the PM 2410 or PM 2411, while the range selector is in position "300 V". The high-ohmic resistor in the probe forms a voltage divider with the input resistance of the PM 2410 or PM 2411.

B. TECHNICAL DATA

Inaccuracy	: 10 % (error PM 2410 or PM 2411 included)
Attenuation	: 100x (in combination with PM 2410 or PM 2411)
Voltage range	: 30 kV max.
Input impedance	: approx. 1200 MΩ
Current consumption	: 25 μA at 30 kV; further proportional to voltage
Dimensions	: 250 x 25 mm diameter (safety ring, 40 mm dia.)
Weight	: [illegible]

Make sure that the earthing-clip is properly earthed during measurements.

C. DISASSEMBLING

- Unscrew safety ring.
- Insulating tube, resistor and cable-holder are now accessible.

D. LIST OF PARTS

Pos.	Fig.	Qty.	Ordering number	Description
1	28	1	4822 268 10003	Test prod
2	28	1	4822 447 60026	Insulating tube
3	28	1.5 m	4822 322 10006	Cable
4	28	1 m	4822 323 20046	Cable (for earth connection)
5	28	1	4822 290 40042	Earthing clip
6	28	1	4822 264 30034	4-mm plug red
7	28	1	4822 264 30033	4-mm plug black
R1	28	1	4822 111 70104	Resistor 1200 MΩ ± 5 %

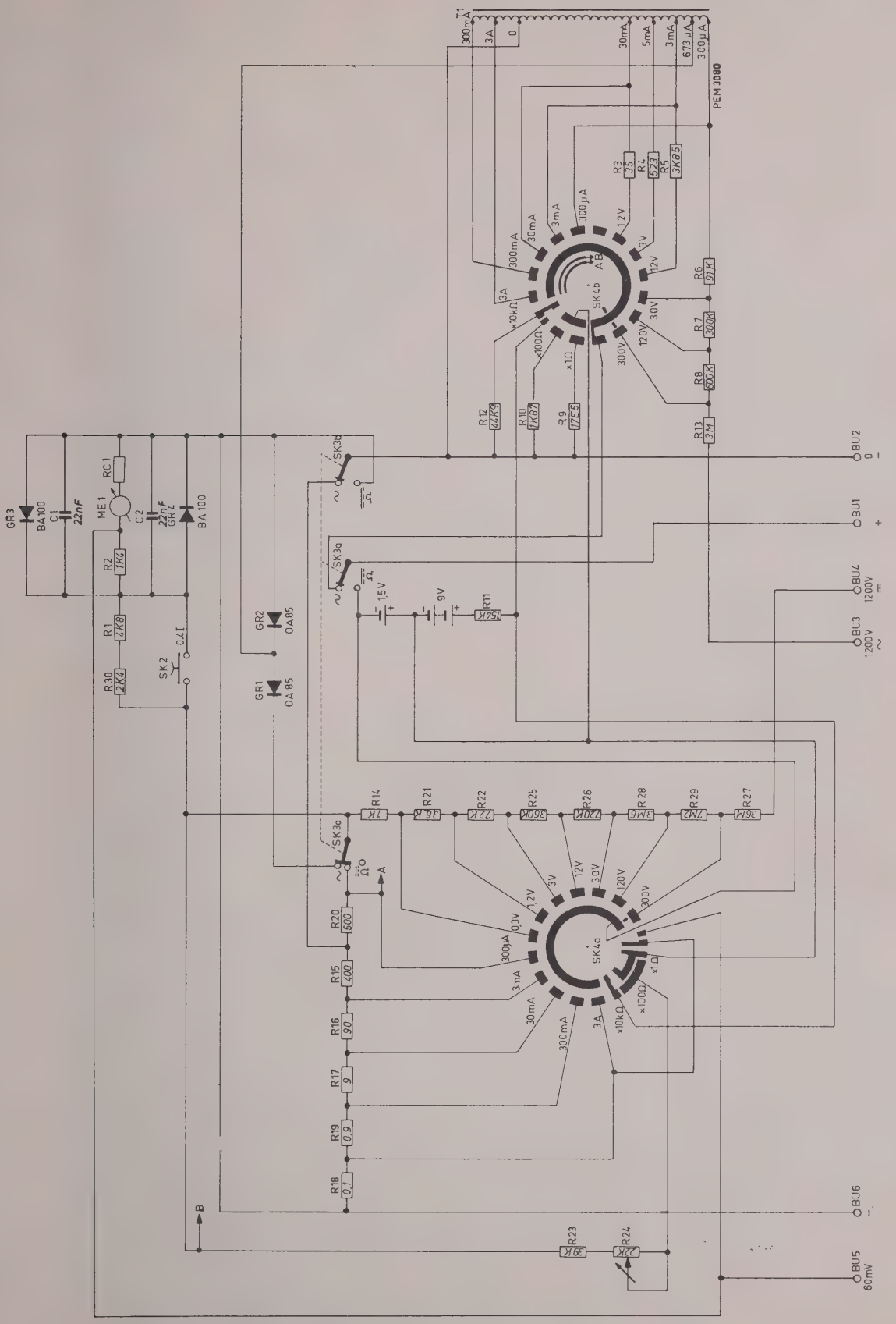

T1
PEM 3080
SK4b
SK4a
SK3a
SK3b
SK3c
SK2
ME1
RC1
GR1
GR2
GR3
GR4
BU1
BU2
BU3
BU4
BU5
BU6
A
B

Fig. 1

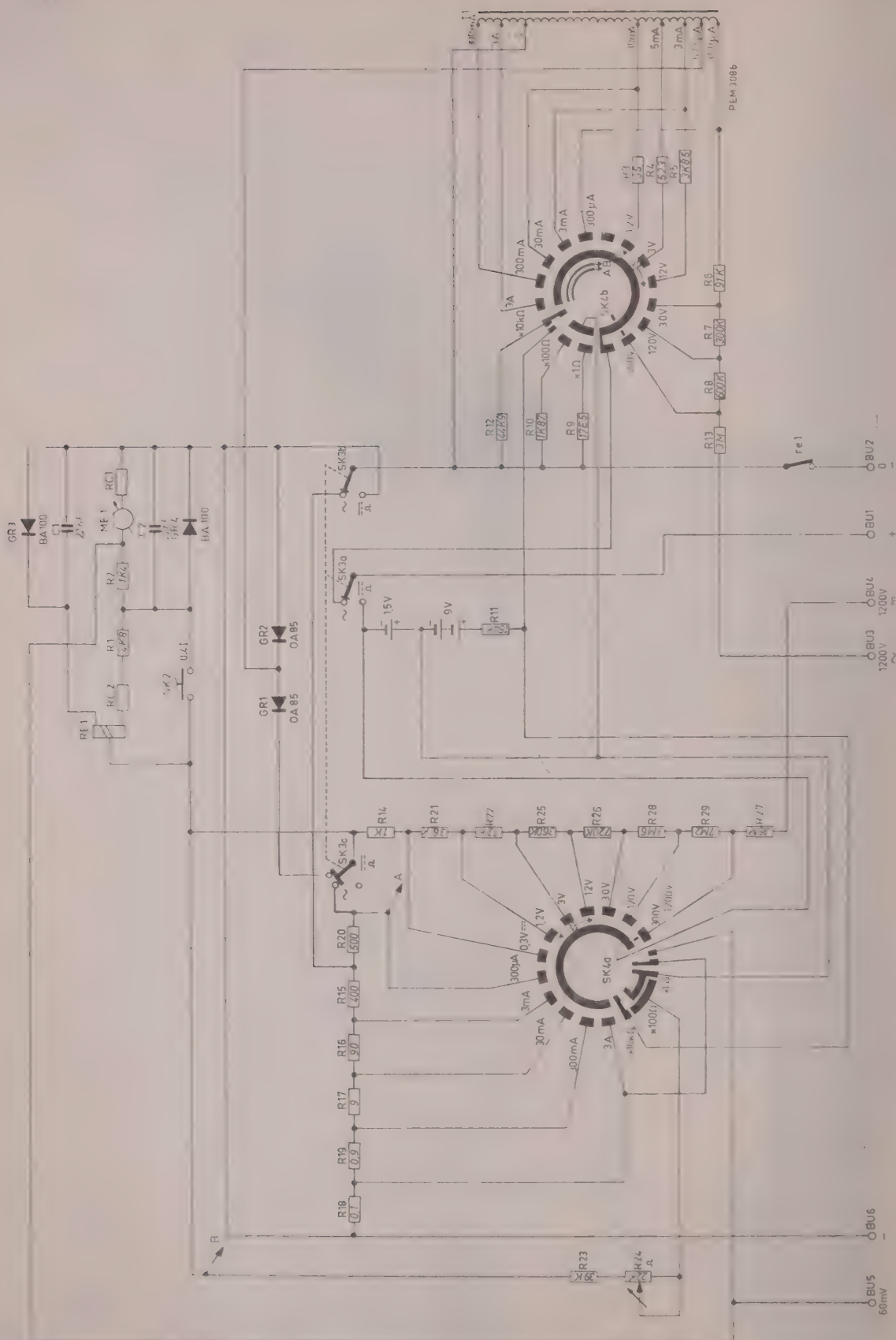

PEM 3086
SK4b
SK4a
SK3a
SK3b
SK3c
GR1
GR2
GR3
OA 85
BA 100
ME 1
RE 1
RC1
SK2
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
R14
R15
R16
R17
R18
R19
R20
R21
R23
R24
R25
R26
R27
R28
R29
R30
1,5V
9V
BU1
BU2
BU3
BU4
BU5
BU6
1200V
60mV

Fig. 2

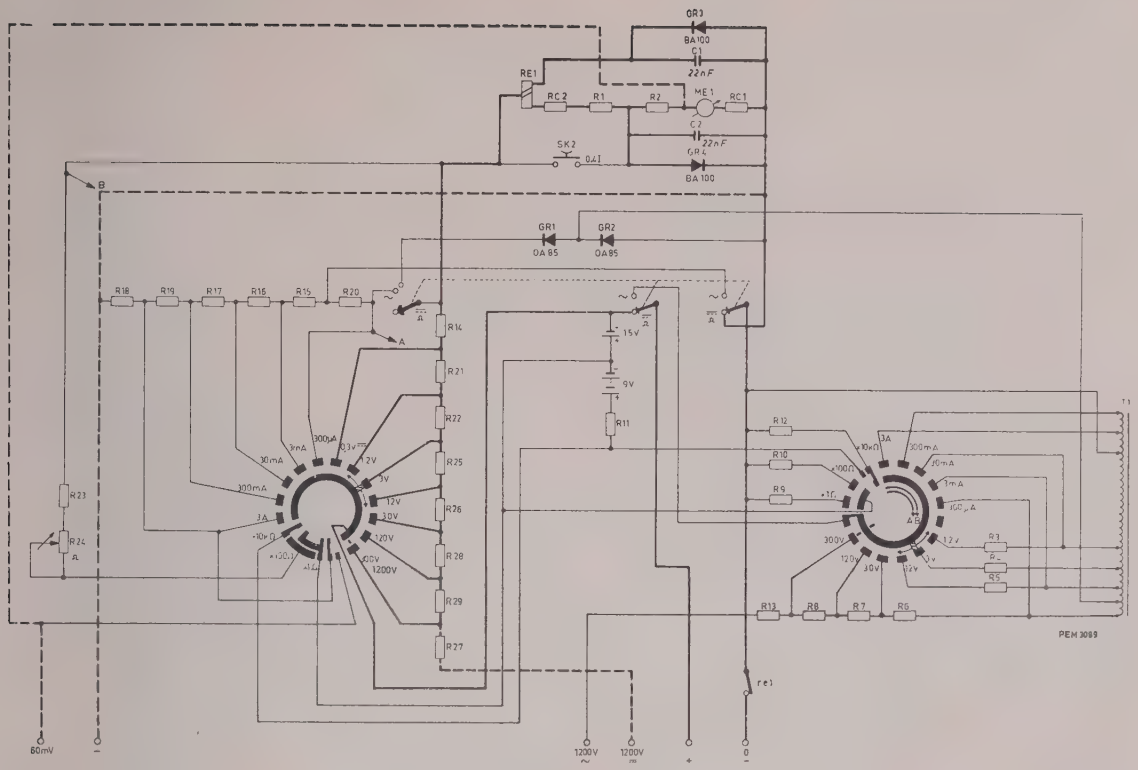

GR3
BA100
C1
22nF
RE1
RC2
R1
R2
ME1
RC1
C2
22nF
SK2
0,4 I
GR4
BA100
GR1
OA85
GR2
OA85
R18
R19
R17
R16
R15
R20
R14
R21
R22
R25
R26
R28
R29
R27
R23
R24
15V
9V
R11
R12
R10
R9
R13
R8
R7
R6
R3
R4
R5
T1
PEM 3089
rel
60mV
1200V
0

Fig. 3

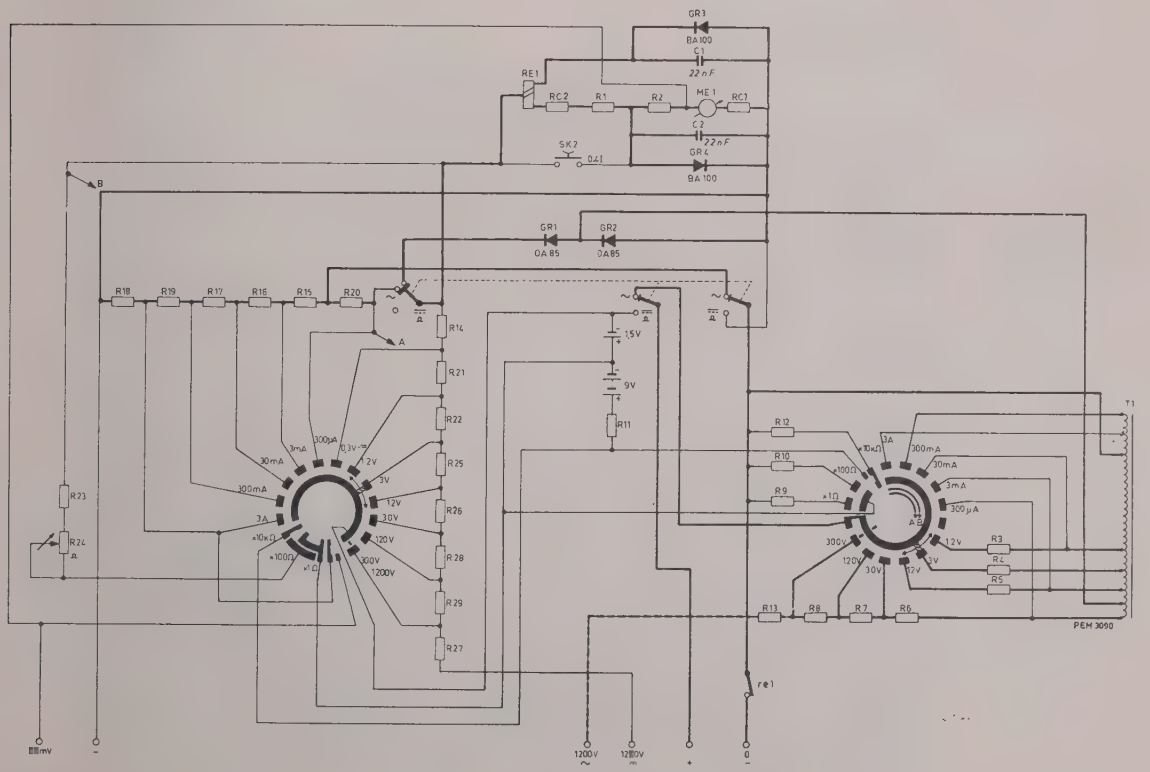

GR3
BA100
C1
22nF
RE1
RC2
R1
R2
ME1
RC1
C2
22nF
SK2
0,4 I
GR4
BA100
GR1
OA85
GR2
OA85
R18
R19
R17
R16
R15
R20
R14
R21
R22
R25
R26
R28
R29
R27
R23
R24
15V
9V
R11
R12
R10
R9
R13
R8
R7
R6
R3
R4
R5
T1
PEM 3090
rel
1200V
0

Fig. 4

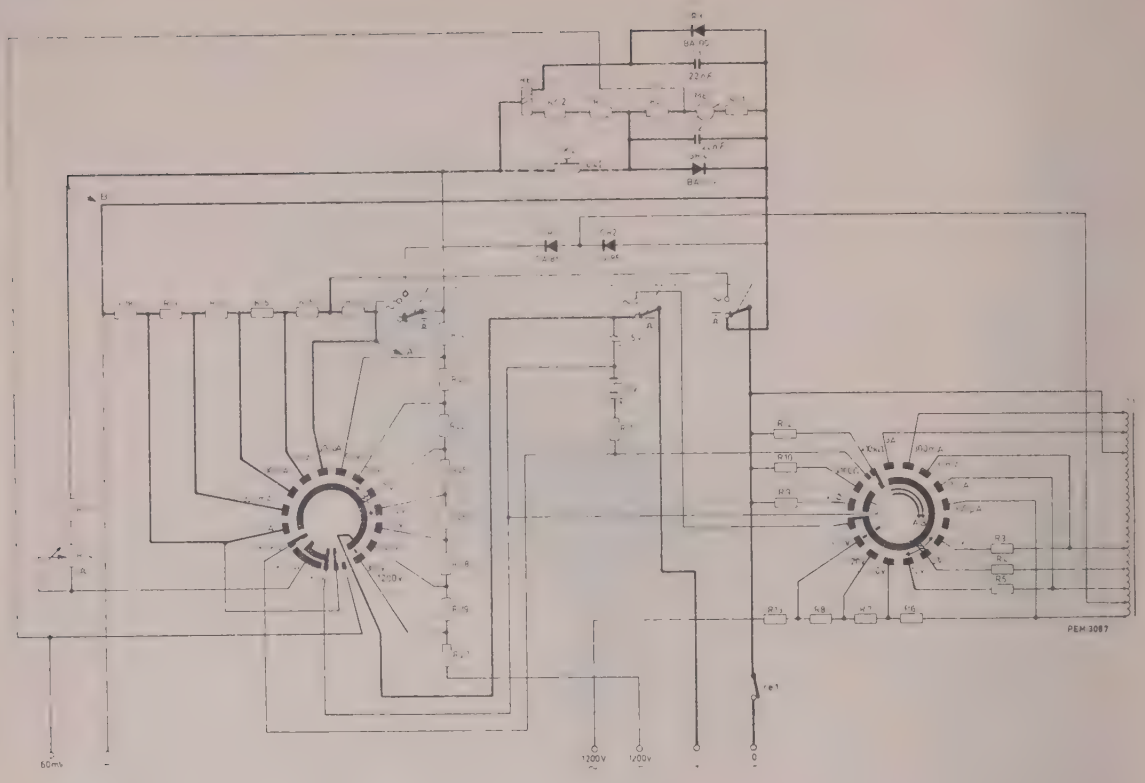


Fig. 5

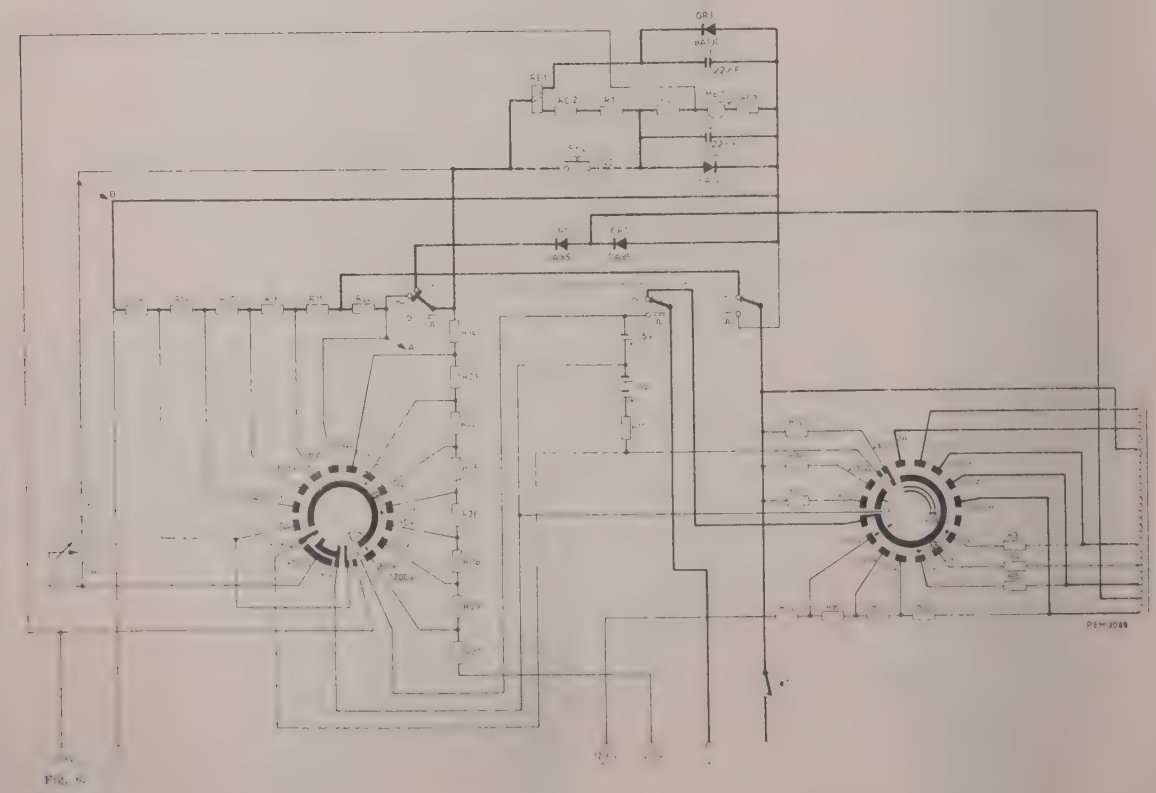
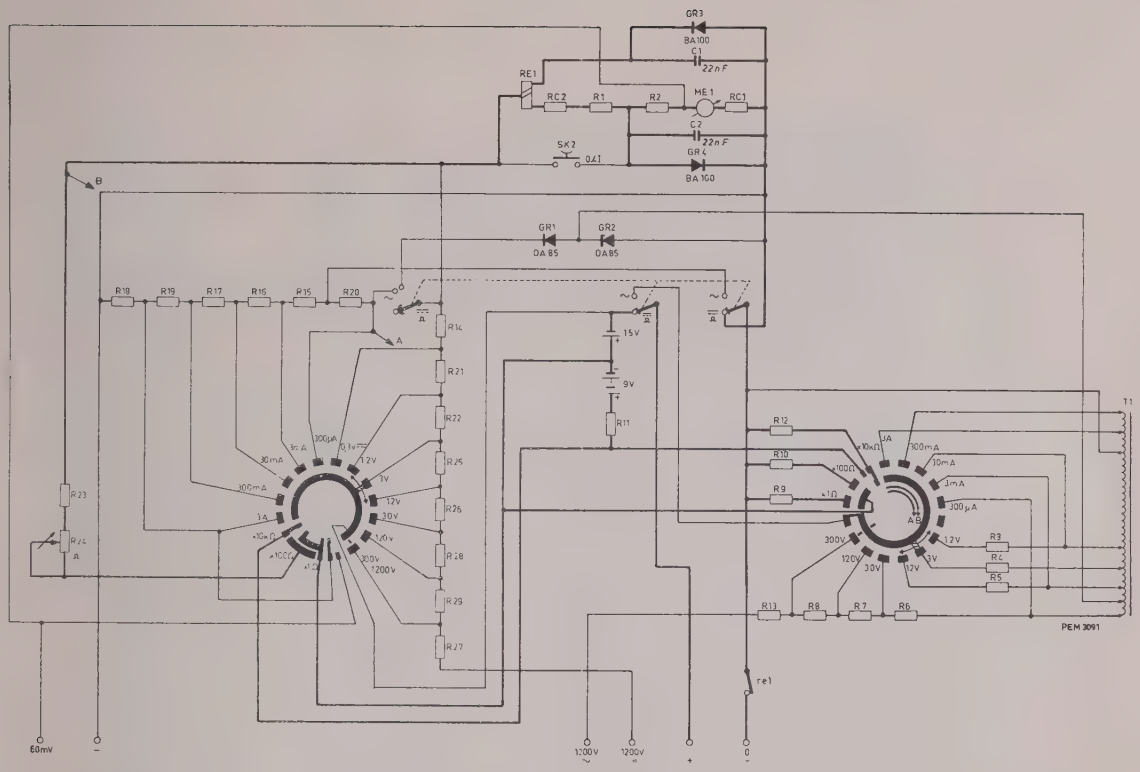


Fig. 6


GR3
BA100
C1
22nF
RE1
RC2
R1
R2
ME1
RC1
C2
22nF
SK2
GR4
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GR1
OA85
GR2
OA85
R18
R19
R17
R16
R15
R20
R14
R21
R22
R25
R26
R28
R29
R27
R23
R24
15V
9V
R11
R12
R10
R9
R13
R8
R7
R6
R3
R4
R5
T1
PEM 3091
rel
60mV
1200V
1200V

Fig. 7

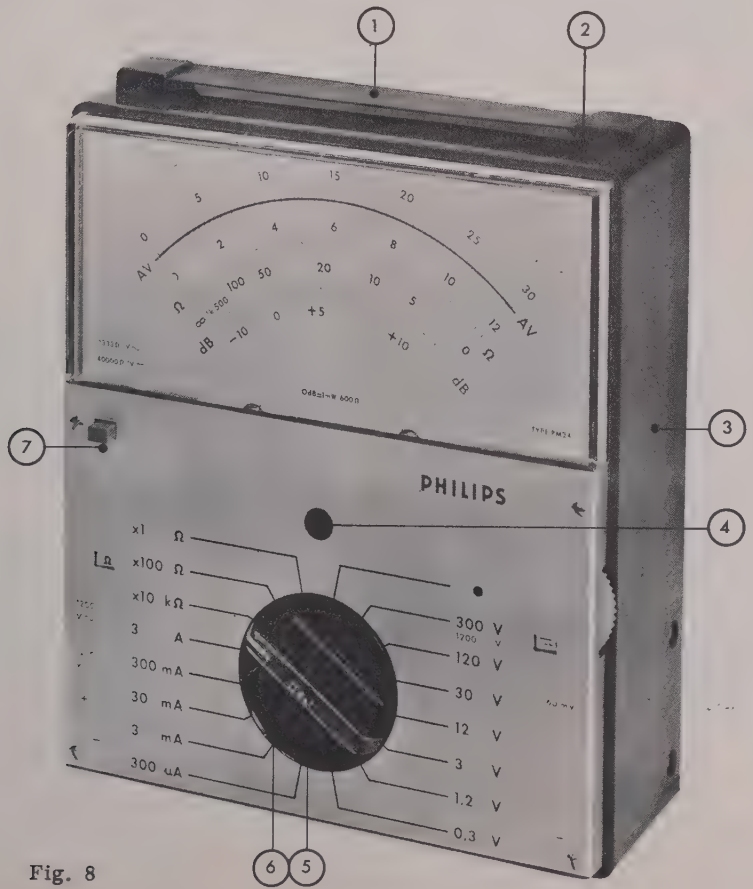

1
2
3
4
5
6
7
PHILIPS
x1 Ω
x100 Ω
x10 kΩ
3 A
300 mA
30 mA
3 mA
300 µA
300 V
120 V
30 V
12 V
3 V
1.2 V
0.3 V
PEM 3437

Fig. 8

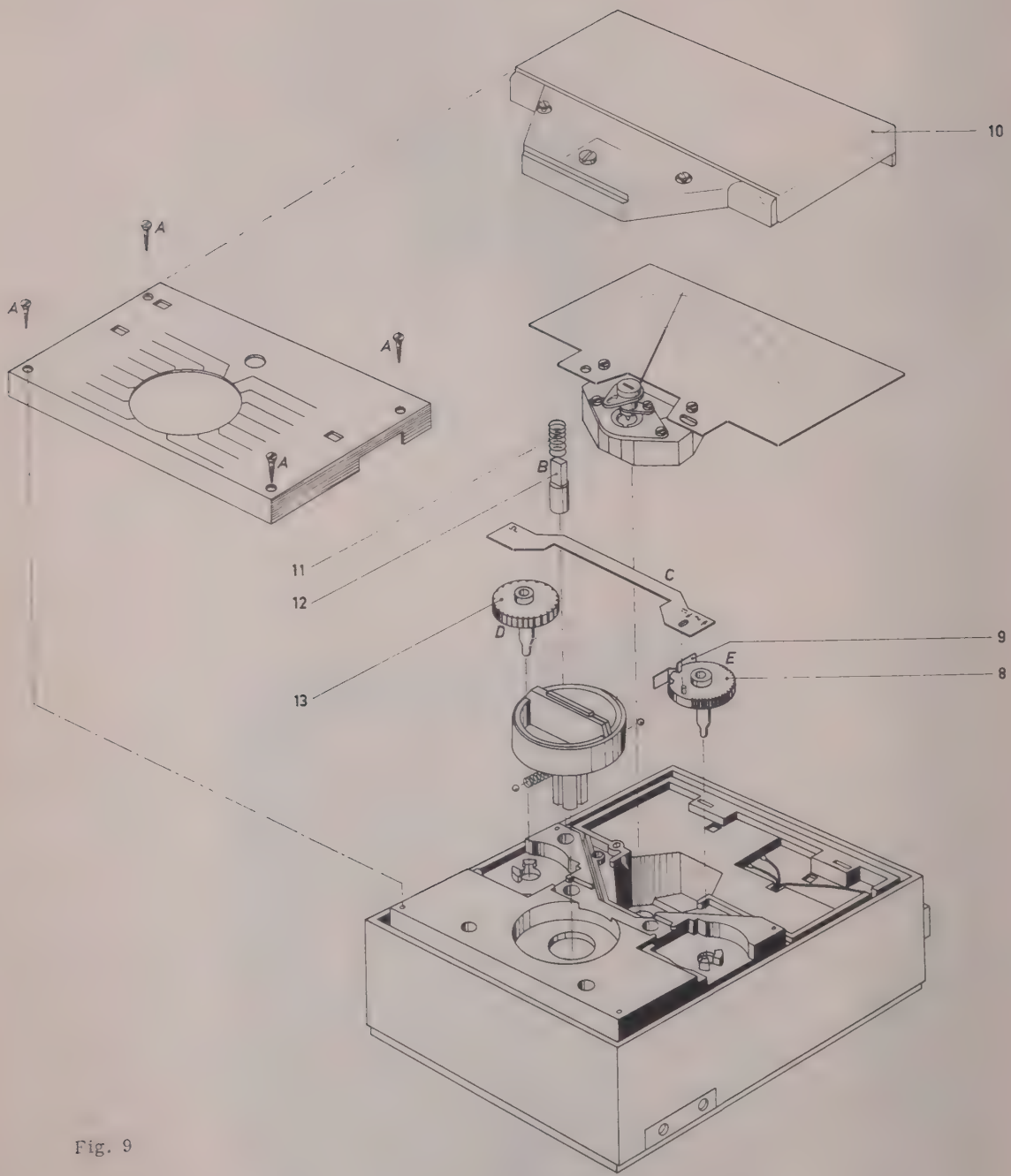


Fig. 9

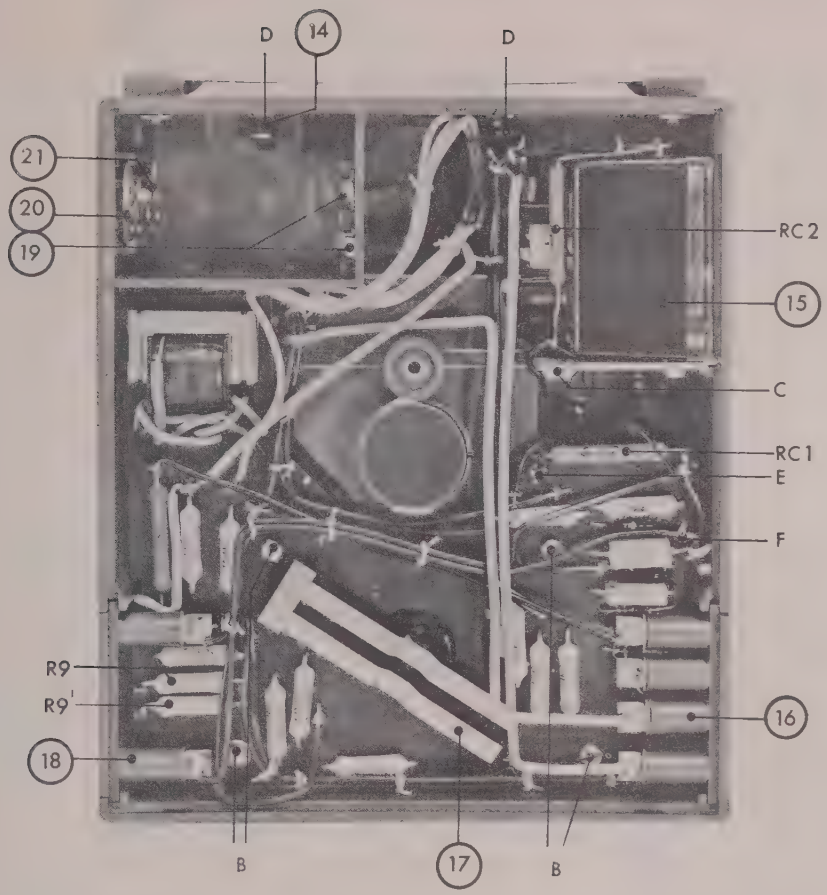
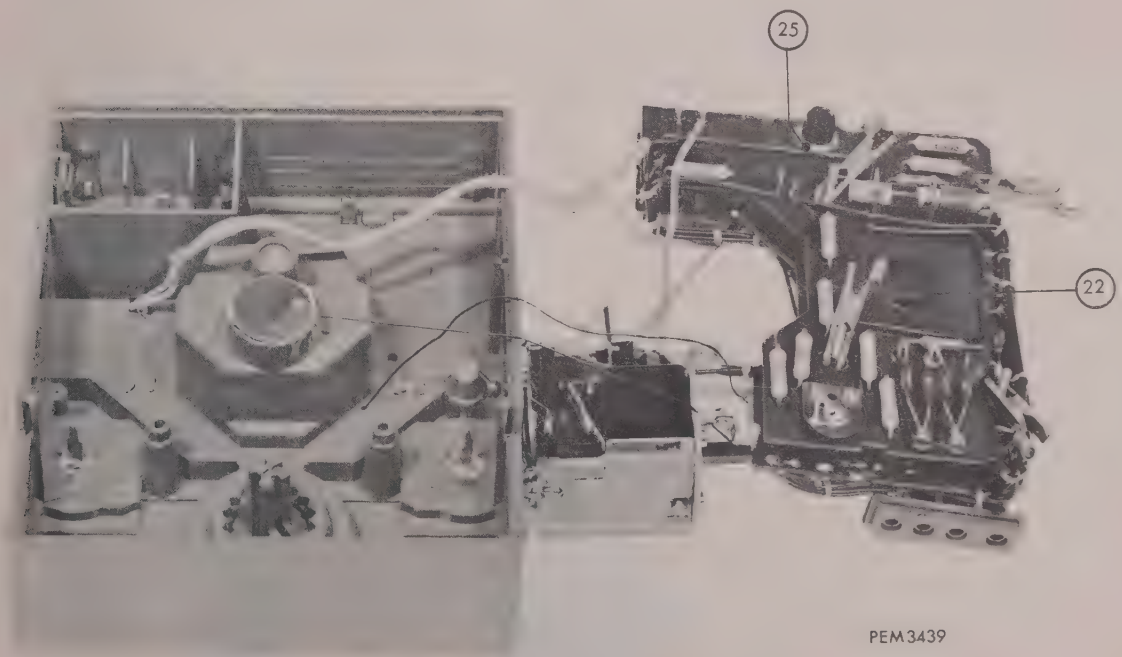


Fig. 10

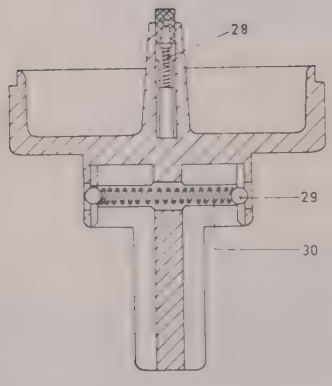
PEM 3438



PEM 3439

Fig. 11

Fig. 12



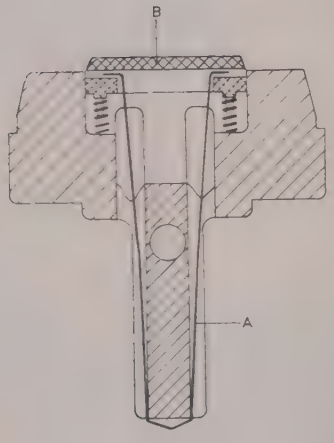


Fig. 13

PEM 3447

Fig. 14

CS4368

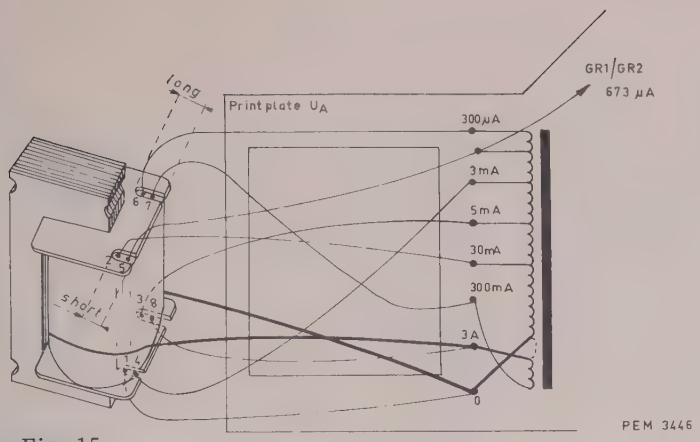


Fig. 15

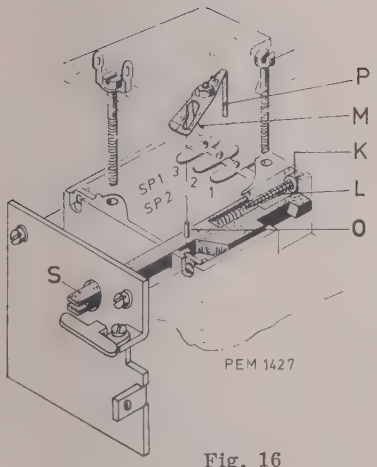


Fig. 16

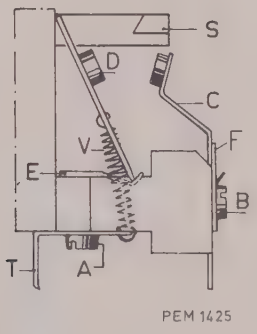


Fig. 17

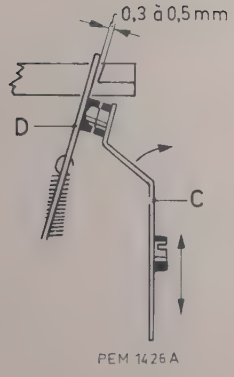


Fig. 18

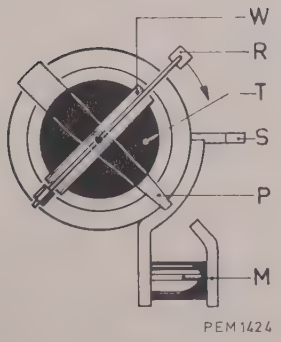


Fig. 19

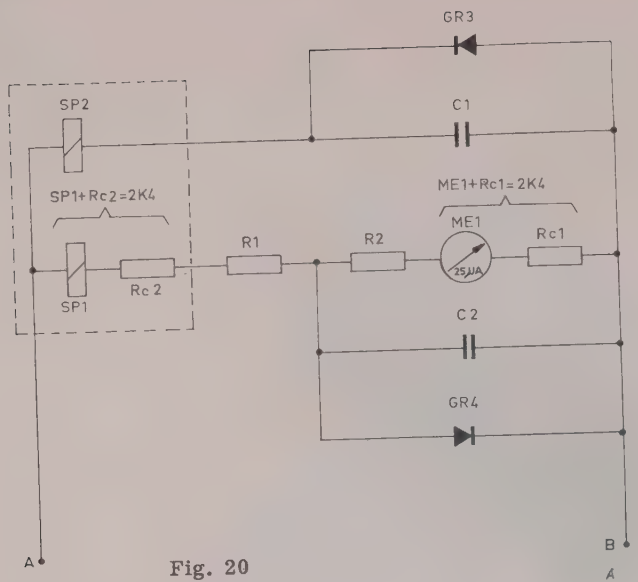


Fig. 20

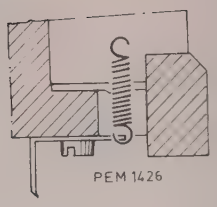


Fig. 21

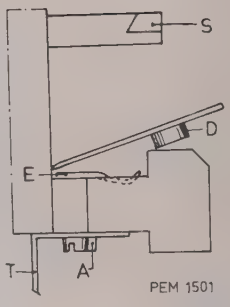
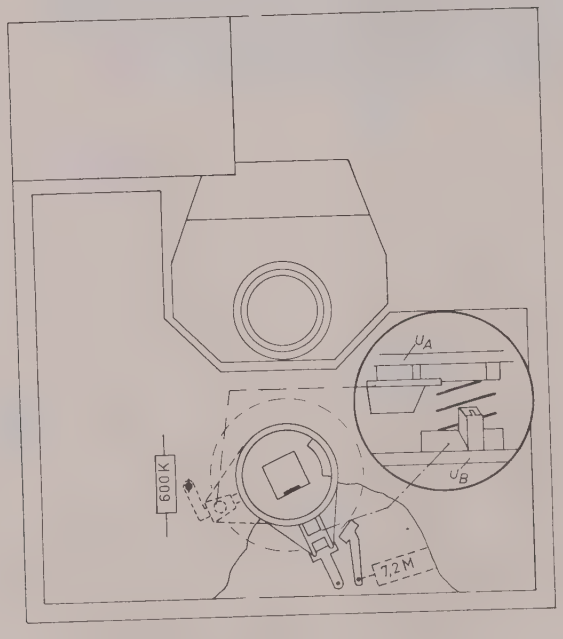


Fig. 22



SEEN FROM REAR SIDE
RANGE SELECTOR KNOB IN POSITION ●

PEM3451

Fig. 23

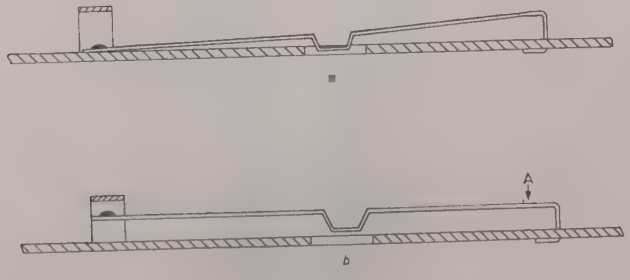


Fig. 24

PEM 3450

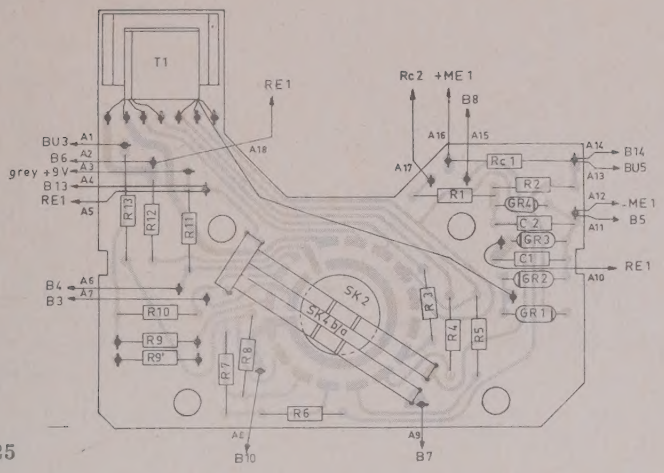


Fig. 25

PEM 3449

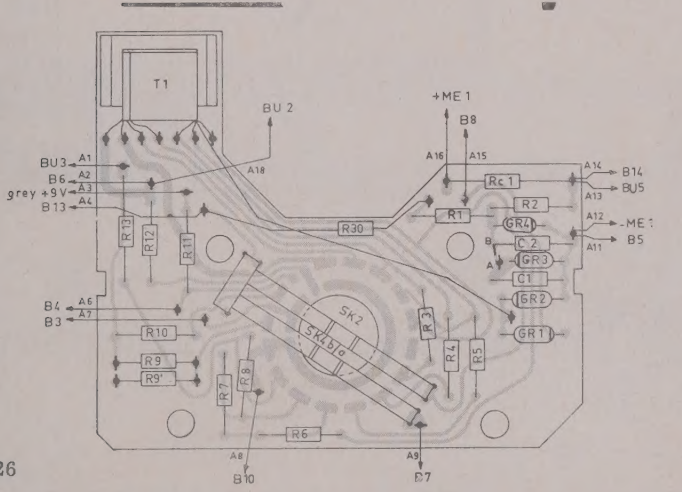


Fig. 26

PEM 3443

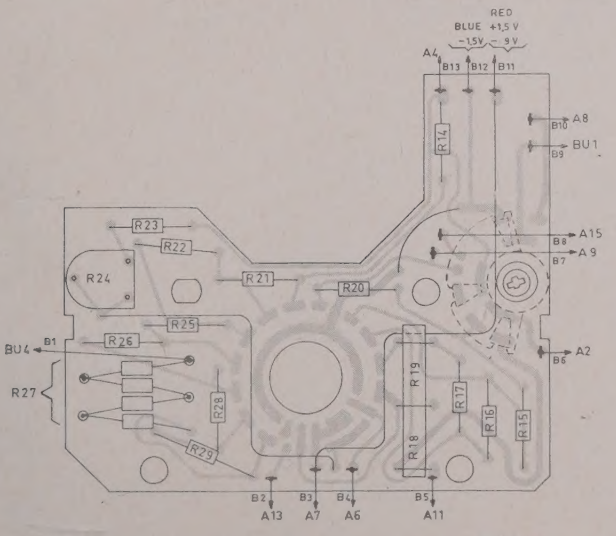


Fig. 27

PEM 3442

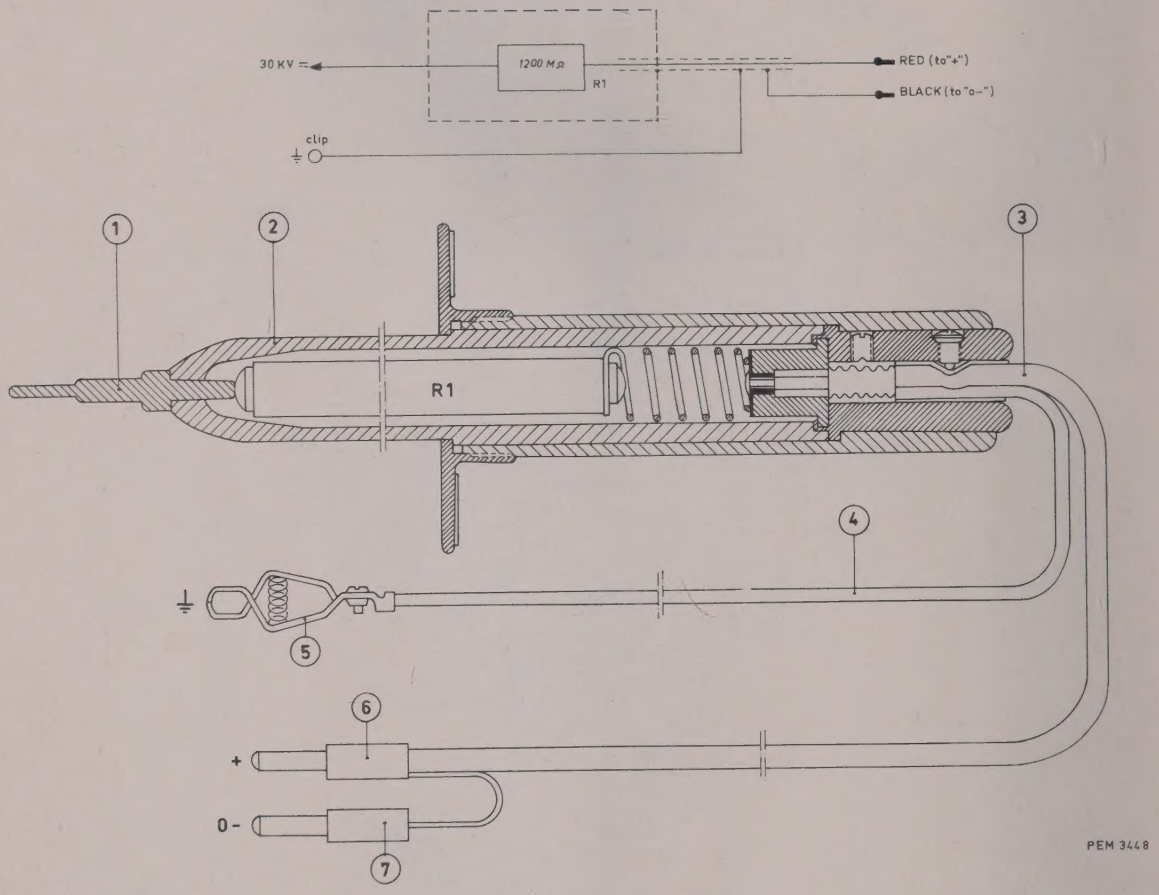


Fig. 28

MP MASTER
MA24545